Extreme Precision Photometry and Radial Velocimetry from the Ground for TESS and Beyond

Completed Technology Project (2016 - 2019)

Project Introduction

NASA's TESS mission is expected to find thousands of planets smaller than Neptune, and dozens of planets that are comparable in size to the Earth. However, the TESS follow-up program is starved for sufficiently high-precision ground-based follow-up resources to confirm and characterize the slew of planet candidates. I propose to deploy instrumentation capable of hitherto unavailable high precision photometry and spectroscopy from the ground. This capability will facilitate rapid follow-up of TESS planet candidates, allowing the community to focus on the highest priority candidate planets—the terrestrial worlds on the shortlist for careful atmospheric characterization with JWST. I propose to: A) deploy an engineered diffuser at the Astrophysical Research Council Telescope Imaging Camera (ARCTIC) at the ARC 3.5m telescope, to enable space-quality photometry (~100ppm) of bright stars from the ground; B) continue my research on the Environmental Control System (ECS) of the Habitable Zone Planet Finder (HPF), an ultra-stabilized spectrograph capable of 1m/s precision in the NIR, to be deployed at the 10m class Hobby-Eberly Telescope (HET) to look for rocky planets in the habitable zones of nearby M-dwarfs. Additionally, I am a part of a team in the development phase for the NASA/NSF Extreme Precision Doppler Spectrograph (EPDS), the next generation spectrograph for the WIYN telescope at Kitt Peak. The project is advancing on both fronts: A) I have already tested an engineered diffuser from RPC Photonics in the lab: the diffuser is capable of homogenizing and shaping the input beam, imaging a small point source into a clean and stable top-hat shape distributed over many pixels. Over the next few months I will work with vendors and collaborators at the ARC to procure an optimized diffuser for deployment at ARCTIC in late 2016. B) We have already demonstrated sub-mK temperature stability of the HPF ECS over more than two weeks, and pressure stability of <10^-7 Torr over months, far exceeding the environmental stability requirements required for both HPF and EPDS—an exciting milestone for precise environmental stabilization of astronomical instruments. We will commission HPF on-sky in early 2017. This project directly supports past (Kepler), present (K2), and future (TESS, JWST) NASA astrophysics missions through the development of new ground-based instrumentation capable of high-precision photometry and spectroscopy. Improvements on both fronts will enable more detections of rocky planets in the habitable zones of their host stars, advancing one of NASA's Science Plan Objectives of "searching for life on planets around other stars".

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Astrophysics

Project Management

Program Manager:

Joe Hill-kittle

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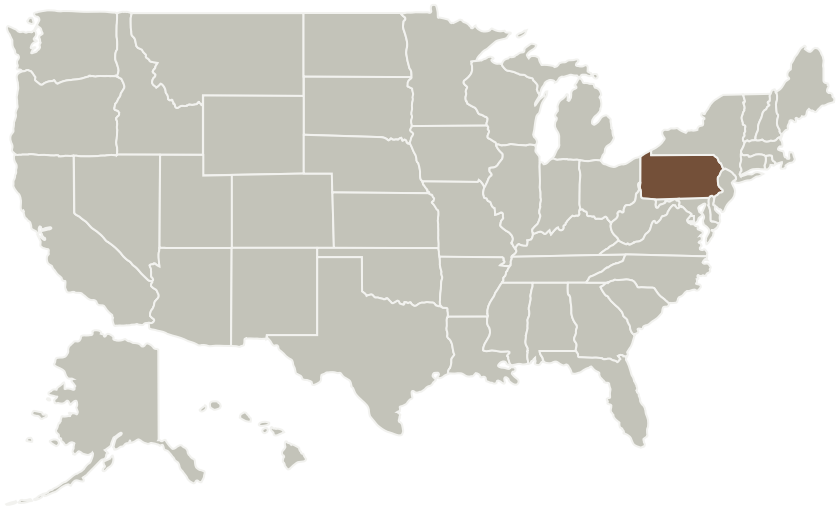
Primary U.S. Work Locations and Key Partners



Primary U.S. Work Locations
Pennsylvania

Project Management *(cont.)*

Principal Investigator:

Suvrath Mahadevan

Co-Investigators:

Melissa T Gensimore
Gudmundur K Stefansson

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destination

Outside the Solar System